It is thus not safe to put forward any assumptions, based either upon chemical relationship or similarity of general properties, concerning the behaviour of colouring matters in this respect; and therefore, recognising the value of a systematic examination, the author gives, at considerable length, the results obtained in recent years by Hummel.

When discussing certain experiments in which arc lamps have been employed as the source of illumination, it is stated that the electric light behaves similarly, but less energetically, than sunlight; the average bleaching action of sunlight having been estimated at 30 per cent. of its total luminosity, while that of the electric arc is only about 6 per cent.

The third section of the first volume deals with operations subsequent to dyeing, such as soaping, milling, steaming, &c. It is very short, extending only to four pages. Two appendices, the first dealing with theories of dyeing, and the second with the elements of chromatics, are added, and the volume ends with a very complete bibliography of the works on dyeing published during the last 100 years.

The second volume is devoted to a description of the machinery used in dyeing and allied processes, a very large space, equal in fact to the whole of the first volume, being occupied by the subject of water purification; which, although of great importance to the dyer, certainly receives undue prominence. The great fault of the work, as a whole, is indeed a certain lack of proportion; many essential points receiving scant attention, while valuable space is occupied to smaller advantage by long descriptions of less important subjects—such, for instance, as the Westinghouse air-pump. Nevertheless, the book should prove a valuable reference work for managers of works, or students of dyeing, to whom it can be heartily recommended.

Walter M. Gardner.

OUR BOOK SHELF.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. "Moths," Vol. iii. By G. F. Hampson. (London: Taylor and Francis, 1895.)

We have already noticed the two preceding volumes of this work in some detail; and it is therefore unnecessary to say more respecting the general execution of this volume than that the letterpress is arranged in a similar manner, and that the execution of the woodcuts is equally good. The present volume includes the last two subfamilies of the *Noctuidæ*, the *Focillinæ*, and the *Deltoidinæ*, and one or two small families of the *Geometridæ*. Respecting the *Deltoidinæ*, Mr. Hampson remarks: "It exhibits a gradual development from forms with straight palpi fringed with hairs above, such as *Hypenæ*, which is closely allied to the *Sarrothripinæ*, and to the ancestors of the *Noctuidæ* and *Nolinæ*, through forms with oblique palpi, to a group possessing palpi of an extremely curved sickle-shaped type; from this group arose the stouter-built, more typically noctuiform and nocturnal *Focillinæ* and *Quadrifinæ*." We seriously doubt the advisability of speaking in such a positive manner on questions which cannot, in the present state of our knowledge, be anything more than very doubtful inductions, at the best.

After the *Noctuidæ*, Mr. Hampson places the families *Epicopiidæ*, *Uraniidæ*, *Epiplemidæ*, and *Geometridæ*, for the last of which he has followed Mr. Meyrick's classification. Under the *Uraniidæ* he includes a considerable number of genera, most of which, except *Nyctalemon*, were included by previous authors in the *Microniidæ*, and other families of *Geometridæ*. A fourth volume is to conclude the Indian *Macro-Lepidoptera*, and to contain the *Pyralidæ* and a supplement; and we are glad to learn that Lord Walsingham is working at the *Micro-Lepidoptera* of India.

Mr. Hampson speaks of the difficulty of the sub-family *Boarmiinæ* in the *Geometridæ;* and under the genus *Boarmia* itself he includes no less than eighty-five species, divided into several sections, to some of which sub-generic names are applied. As, however, no less than twenty-eight generic names are included as synonyms of *Boarmia*, we think it would have been better to have treated some, at least, as provisionally entitled to generic rank. And this leads us to a consideration of the most serious defect in all Mr. Hampson's work, which has already been pointed out in more than one quarter. He is too much inclined to place forms together as varieties, and then to treat them as actual synonyms. It is true that in a few instances in the present volume he discriminates between named varieties; but far more frequently he gives a description of a species in a few lines, preceded by a string of half-a-dozen or more names, without any hint of how far these names represent distinct forms, or which names represent his idea of the species he is describing, even when he notices that the species is variable. While making allowance for exigencies of space, this is hardly fair to those who will use his books; for even if we assume that Mr. Hampson is always correct in his views as to which forms are entitled to specific rank, and which are only to be regarded as varieties, it is not to be supposed that every one will take exactly the same view of a doubtful case; and we greatly fear that if an entomologist meets with an insect which does not correspond with the description of a species given by Mr. Hampson, he will at once describe it as new, and, in many cases, redescribe one of the forms which Mr. Hampson has rejected, with a light heart, as a mere synonym.

Apart from this serious defect, we can recommend the book as a most useful and, indeed, quite indispensable manual for all who are interested in East Indian Moths.

W. F. Kirby.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

The Origin of the Cultivated Cineraria.

Returning from abroad, I have just seen Mr. Dyer's letter in Nature, March 14. Of the matters there treated I ask leave now to deal with one only, that numbered (18). This is a point of fact—the origin of the cultivated Cineraria. At a meeting of the Royal Society, on February 28, Mr. Dyer exhibited a specimen of *Cineraria cruenta* from the Canaries, side by side with a plant of the common cultivated form. With the object of minimising the value of "sports" in evolution, this exhibition was made to illustrate what can be done "by the gradual accumulation of small variations." Mr. Dyer stated, if I rightly understood him, first, that of the two forms exhibited, the one had been produced from the other; secondly, that, as far as is known, this process of evolution had been accomplished by the gradual accumulation of small variations, and not by the selection of "sports" or seedlings presenting notable and striking variations. That in the case of a plant much modified by gardeners in recent times such a history would be highly unusual, Mr. Dyer will, I think, admit.

Doubting this account, and searching records of the early culture of the Cineraria for my own satisfaction, I found a good deal of miscellaneous information on the subject. The history is not yet quite complete; but as Mr. Dyer's account has now appeared in print, the following notes may be of use.

In the ordinary manuals (*e.g.* Burbidge, *Propagation* &c., 1877, p. 250) it is said that the florists' Cinerarias are *hybrids*, obtained by crossing and recrossing several species of *Cineraria* (or more strictly *Senecio*). As to the exact parentage, there is not entire certainty. Burbidge gives *C. cruenta*, *aurita* and *lanata* as the parents. Other writers mention *C. maderensis*, *multiflora*, *tussilaginis* and *populifolia* as having contributed (*cp. Jour. d'hort.* Gand, ii. 1846, p. 231). General statements of a like nature are made by many. For the account given by Mr. Dyer I find no authority except one, an article by Rolfe (*Gard. Chron.* 1888 (1), p. 653). Here *C. cruenta* is given as the sole parent, and a figure of this species raised at Kew, from wild seed, is shown beside two extreme flowers of the modern type. Excepting this statement, it seems agreed that the species originally concerned are at least four: *cruenta*, *aurita*, *populifolia* and *lanata*. The first three have comparatively small flowers in corymbs or cymes. Those of *cruenta*, introduced from Canary by Masson to Kew in 1777, are purple. This species was originally described from Teneriffe by L'Héritier, *Sert. Angl.* 1788, pl. 33, and is figured *Bot. Mag.* t. 406, and elsewhere. The lower surface of the leaves is purplish. The petioles have auricular expansions. *C. aurita*, sent to Kew from Madeira 1790, figured by L'Héritier, pl. 31, and *Bot. Mag.* t. 1786, is a somewhat different plant, of more slender habit, said to be more akin to *populifolia*. The flowers are purple. Ray-florets few and irregular. Petiolar expansions variable, mostly much smaller than in *cruenta*. *C. populifolia* L. Hér., Canaries, brought by Masson from Teneriffe 1780, is a form with yellow flowers. *C. lanata*, L'Hér. pl. 30, and *Bot. Mag.* t. 53, is a plant very different from any of the others. It bears large purple flowers, some two inches across, only one to a peduncle. The leaves are cordate-subrotund and septangular, and woolly underneath. L'Héritier gives it as from Teneriffe. The *Bot. Mag.* wrongly says it had been introduced from Africa (perhaps confusing with *lanosa*, DC. = *lanata* Thunb.). The large flowers and peculiar leaves at once distinguish this species from the rest.

It should be added that *populifolia* in its native state showed considerable diversity in the forms of its leaves, three varieties being specified by Decandolle, *Prodr.* vi. p. 409. A natural variety of the same species with *white* flowers was brought from Teneriffe by Webb. This is the *β. leucanthus* DC. It is figured in *Flor. Cab.* i. p. 73, from a specimen grown in Birmingham Botanic Garden. As to these species, references to further information may be found in Decandolle, *Prodr.*, and in Webb, *Phytogr. Canar.*, &c.

These four species with others were at the beginning of this century pretty generally distributed in greenhouses in England, France, and Germany. They are enumerated in most of the horticultural treatises of the period, with directions for their propagation. *C. lanata* was thought the best. "It far exceeds all others cultivated here in the beauty of its flowers. . . . It is valuable on account of its hardiness, its readiness to flower, and the facility with which it may be propagated." Rees' *Cycl. of Arts and Sci.* viii. 1819. Others speak to like effect.

The first mention I have found of any distinct garden form is that of Willdenow, who in "Enum. Pl. Berol." 1809, p. 893, gives *C. hybrida*, saying that this plant is grown in gardens under the name of *C. cruenta*, but that it in reality differs much from the latter, and has flowers almost like those of *C. lanata*.

Between 1820 and 1830 definite efforts were made to improve the Cineraria. The first published is that of Bouché. Writing in the "Verh. zur Beförd. d. Gartenbauer, Berl.," i. 1824, p. 139, he says that having grown *C. lanata* L'Hér., *C. cruenta* L'Hér., and *C. hybrida* Willd., and noticed that the first two seeded freely, it occurred to him to try to raise varieties or sports (*Spielarten*), and at the same time to test the distinctness of these species. His seedlings flowered in the following year. Those from *C. cruenta* had the flowers rose-red, except one which was quite white, the flowers of the parent being dark red. The seedlings from *C. hybrida* varied so much that they might be mistaken for separate species. His words are as follows:—"Unter denen von der Cin. hybrida zeichneten sich besonders fünf Abänderungen aus, welche eine ganz eigenthümliches Ansehen bekommen haben, und leicht von Botanikern, denen die Entstehungsart derselben nicht bekannt ist, für neue, noch unbeschriebene Arten dieser Gattung gehalten werden könnten." His description follows. In particular, the foliage had varied greatly from the parent form, somewhat resembling *lanata*, suggesting to Bouché that there may have been hybridisation with that species.

About the same time Mr. Drummond, then Curator of the Botanic Garden, Cork, published a paper in the *Gard. Mag.* ii. 1827, p. 153. He says that Cinerarias are favourites with him, especially *cruenta*, "for besides the great beauty and variety in the flowers, its fine purple blossoms form a beautiful contrast, &c." "We seldom see it cultivated to the extent it merits. The following account of the method I have followed for some years of growing this plant. . . may turn the attention of your readers to the cultivation of the *C. cruenta*, the effects of which *will, in all probability, be the production of fine double and single varieties of different colours, as it sports greatly from seed.* [Italics are mine.] Except in cases when it becomes desirable to preserve any particular variety for its superior beauty, I prefer raising the *C. cruenta* from seeds. . . . Care should be taken to select the finest varieties, and those that produce the largest and finest heads or corymbs of flowers." "The other greenhouse species I cultivate are *lanata*, *hybrida*, *geifolia* and *amelloides*. These I increase by cuttings, &c."

It happens that in the same year (1827) of the *Gard. Mag.* p. 446, there is a reference to Bouché's paper. Not improbably Drummond may have read the latter, for in Loudon's *Ladies' Mag. of Gard.* 1842, p. 111, I find this passage: "Most of the purple Cinerarias are varieties or hybrids of *C. cruenta*. . . . It was long a favourite in greenhouses, and was generally propagated by dividing the roots; but about 1827, Mr. Drummond, Curator of the Botanic Garden in Cork, having raised it from seed, and found the seedlings vary considerably, conceived the idea of hybridising it with *C. lanata*, *C. geifolia* and *C. amelloides*. The trials, however, with *C. geifolia* [a true Cape Cineraria] and *C.* [*Agathæa*] *amelloides* do not appear to have succeeded; but between *C. cruenta* and *C. lanata* some handsome hybrids were raised. Since that time numerous experiments have been made and hybrids have been raised, &c." A summary follows.

Soon after this a number of definite seedlings or "sports" came into existence. Of some of these there are good records. I will mention four which are represented by good coloured plates. *C. waterhousiana* is said to have been a hybrid, the result of the seed of *C. tussilaginis*, fertilised by the pollen of *cruenta* (*Paxton's Mag. of Bot.* iv. 1838, p. 43, and *Ladies' Mag. l.c.*). In general appearance it rather resembled *tussilaginis* (one of L'Héritier's species which had died out, and was introduced again in 1832 by Webb. See *Bot. Mag.* t. 3215.) This must have been a very fine plant. It had large *red* flowers, about two and a half inches across, with long narrow ray-florets something like *lanata*.

The next case I shall take is a plant which first flowered in a garden near Belfast, called var. *cyanophthalmus* in *Bot. Mag.* 1840, t. 3827. It had long white rays and a *blue* disc. Sir W. J. Hooker says of it: "Notwithstanding the very unusual colour of the flowers for one of the Compositæ, I have little hesitation in referring it to . . . the old *C. lanata* of our gardens. The foliage is the same, and the structure of the flowers; but the colour of the blossoms is very different, and in our variety of a most unusual character." He then recalls Decandolle's well-known remark that *yellow* in Compositæ may vary to red or white, but not to blue, and, on the other hand, that *blue* may vary to red or white, but never into yellow. He adds: "Not only in our plant is the lilac-coloured ray of the flower changed to white, and the deep lilac or blood-red purple of the ray [disc] changed to a very bright blue, but the stigmas, which are deep orange in the original stock, are also intensely blue, and the anthers are purple-black."

Another seedling of a very different type, famous in its day, was *webberiana*. It was figured in *Paxt. Mag. Bot.* ix. 1842, p. 125. The flowers were of a deep blue, the rays being short and wide, compared to those of *waterhousiana*, for example. "It was raised from seed ripened promiscuously on a number of plants of various kinds blooming together, &c." In the *Gard. Chron.* 1842, it was advertised at 10*s*. 6*d*. a plant.

Another sport, pinkish and white, is figured in the *Botanist*, v. 1841, No. 215. "It came up accidentally, some years ago, from self-sown seeds, in one of the pots of the greenhouse, so that I cannot say anything certain about its parentage." The writer conjectures it to be a hybrid between *lanata* and *populifolia*, var. *leucanthus*.

If any one will look at the plates to which I have referred, he may satisfy himself of the astonishing diversity of these forms. In *Gard. Mag.* 1839, p. 430, is an early record of the appearance of the new seedlings at shows. At the Caledonian Horticultural Show, the Cinerarias "were very brilliant, and partook of novelty." The names of the seedlings successful, including *waterhousiana*, are given. At the beginning of the forties the named kinds became very numerous, and were at first offered at high prices in the trade advertisements. Henderson and Ivery were the two chief English cultivators at that time.

During this period, 1830–1840, the progress was very rapid, and there can be no doubt that the florists' Cinerarias came into existence within some ten or twelve years. Such a plate as that in *Jour. d'hort.* Gand, 1846, shows the ordinary kinds much as we know them. From those plants up to the perfected plants of ten years ago, the change was undoubtedly slow and gradual. The alterations have consisted chiefly in increase in size and symmetry of the flower, and in promotion of compactness of habit (see, *e.g.*, Glenny, *Ann. of Hort.* 1850, p. 37, also *Gard. Chron.* 1879 (1), p. 532).

The next point is of some interest. As compared with other "improved" herbaceous plants, the Cineraria is a little peculiar in the fact that it is now generally raised from seed. This is done partly to ensure that the plants shall not be overgrown, and partly to avoid green fly, a pest to which these plants are specially liable. In consequence of this, the old "named" kinds, that is to say, kinds propagated by asexual methods, went out of fashion, though till lately they still had supporters. It was found that seeds of good strains could be fairly relied on—not, of course, to reproduce the form of their particular parents, but to give fine plants. For instance, Henderson, *Scot. Gard.* i. 1852, p. 22, says: "in raising seedlings you should select three or four dwarf varieties, which number is quite sufficient to produce all the different colours." In *Gard. Chron.* 1887 (1), p. 549, are some interesting particulars of the methods used by Mr. James, to whom the later improvement of the plant in England is largely due. The plants of each colour are grouped in blocks, and the bees are freely admitted to the houses. It is not found necessary to separate the plants further, and in saving seed all the colours are mixed together. In the case of the Cineraria therefore, as in that of Calceolarias, Begonias, and other plants much grown from seed, it is desirable not only to create a fine variety of which the stock can at once be multiplied asexually, but also to raise a good strain of which the seedlings come fairly true. The latter process may undoubtedly often take time.

Even in recent times a "sport" has been recorded. In *Gard. Chron.* 1880 (1), p. 277, it is stated that Mr. James "has succeeded in obtaining a new 'break' that promises to be the forerunner of another host of new flowers. The colours of the flower do not shade off into one another, as is usually the case, but are arranged in bold and well-defined belts. . . . We understand that it flowered for the first time last season, and that it has reproduced itself from seed." A figure is given.

To these particulars might be added many more, relating to the origin of double varieties, variations in the foliage, and other matters. The foregoing notes of the history must, I think be taken to show (1) that the modern Cinerarias arose as hybrids derived from several very distinct species; (2) that the hybrid seedlings were from the first highly variable; (3) that "sports" of an extreme kind appeared after hybridisation in the early years of the "improvement" of these plants; (4) that the subsequent perfection of the form, size and habit has proceeded by a slow process of selection. Mr. Dyer's statement that the modern Cinerarias have been evolved from the wild *C. cruenta* "by the gradual accumulation of small variations" is therefore, in my judgment, misleading, for this statement neglects two chief factors in the evolution of the Cineraria, namely, hybridisation and subsequent "sporting."

I have ventured to deal with this case because it seems to be generally supposed by those not acquainted with the facts, that the origin of the modern florists' flowers has in general been very gradual. As a matter of fact it would, I believe, be more true to say that the new departures have in general been at first very rapid, subsequent improvement being commonly slow. "Sporting," usually after hybridisation, has been the chief factor in the production of these new developments, just as in the case of the Cineraria. To speak of no more, I may refer to the new forms of Begonia, of Gladiolus, and of Erica now so familiar. With what special propriety the Cineraria was chosen by Mr. Dyer to support his contention is not evident to me.

Whether any of these sports exhibit the phenomenon of organic stability I cannot now discuss. W. BATESON.

St. John's College, Cambridge, April 17.

The Age of the Earth.

IN Dr. Hobson's letter on this subject, he confuses the argument by the introduction of a new factor (never alluded to in the former discussion, or in my theory as stated in "Island Life"), the *bulk* or *volume* of the matter deposited. This has nothing whatever to do with the practical problem, because it is admittedly impossible to form *any* estimate of the total bulk of all the stratified rocks of the earth during all geological time; while it is equally impossible to form any estimate of the total bulk of the denuded matter, since we have no clue whatever to the number of times the same areas have been again and again denuded. But the maximum *thickness* of the same rocks, compared with the average *rate* of denudation, and the coincident maximum *rate* of deposition, *do* furnish materials for an estimate, since they can all be approximately determined from actual observation; and the result is what I have given. If Dr. Hobson had referred to the former discussion he would have avoided imputing to me "fallacies" which I never made. I never said a word about "equal bulks" of material being deposited in less time than they were denuded. But, as the only available data are those of *thickness*, not bulk, then it is clear that, if the area of deposition is one-nineteenth of the area of denudation, the *rate* of deposition of a known *thickness* of rocks will be nineteen times as great as the known *rate* of denudation. It was necessary for me to point this out when first discussing the subject, because one eminent writer had made the rate of deposition *less* than the rate of denudation, because the water-area is greater than the land-area of the globe; while an eminent geologist has quite recently taken the rates of denudation and deposition as being *equal*. If, however, the area of deposition is very much *less* than the area of denudation, which is now admitted to be the fact, then the *rate* of deposition *per foot of thickness* will be many times *greater* than the *rate* of denudation.

I should not have thought it necessary again to state this very obvious conclusion, had not Prof. Sollas, while so clearly pointing out Dr. Hobson's misconception as to the area over which the maximum thickness of the strata extended, omitted to refer to the confusion he has now for the first time introduced into the problem, by references to the *bulk* or *volume* of the sedimentary rocks, a factor which all previous writers have seen to be wholly beyond even an approximate determination.

ALFRED R. WALLACE.

So little is really known about the earth's age that any additional mode of approximating to it, however rough, may possess some value. The following method of finding a lower limit is, with one or two alterations, the same as that given in a paper in the *Geological Magazine* for 1887 (p. 348). It depends, not on the rate of denudation, but on the rate of subsidence within the area of sedimentation.

Part of the sediment brought down by a river is used for keeping the surface of the delta close to the level of the sea; and the fact that the deposits formed from it are generally shallow-water deposits, shows that the amount of sediment is, as a rule, sufficient or more than sufficient for the purpose. The remainder of the sediment is carried out seawards, and enlarges the delta laterally.

If there were no surplus sediment, it is evident that the mean rate of subsidence over the delta would be obtained by dividing the volume of the sediment brought down annually by the river by the area of the delta. But if there be an excess of sediment, then the same quotient will give a value greater than the mean rate of subsidence, for only part of the sediment is used for keeping the delta-surface in shallow water. In the case of the Mississippi, the amount of sediment brought down annually is 7,459,267,200 cubic feet, and the area of the delta 12,300 square miles, or 342,204,320,000 square feet; so that the mean rate of subsidence is not greater than $\frac{1}{46}$ of a foot per year, or 2·18 feet per century.

Prof. Sollas estimates the total maximum thickness of the different layers of sediment since the beginning of Cambrian